WORKSHOP PROCEEDINGS

Communication and Control Systems for Distributed Energy Implementation and Testing

May 14-15, 2002

Reston, Virginia

Executive Summary

This report presents the proceedings of a technical workshop on communication and control systems for the implementation and testing of distributed energy devices such as microturbines, fuel cells, and photovoltaic arrays. The purpose of the workshop was two-fold:

- To develop ideas for conducting **large-scale demonstration projects** of distributed energy devices in high levels of saturation on particular feeder lines or substations, and geographically dispersed across utility service territories.
- To outline **system architecture** concepts for the communication and control systems that will be needed to operate these devices once large numbers of them have been deployed.

To accomplish these purposes, the workshop brought together representatives from three key industry groups: 1) electric utilities, 2) distributed energy equipment manufacturers, and 3) information technology providers. Also involved were representatives from state energy agencies, universities, and National Laboratories. The workshop was sponsored by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

This workshop, which occurred May 14-15, 2002, in Reston, Virginia, was a follow on event to another technical workshop on communication and control systems for distributed energy systems which took place September 25-26, 2001, in Keystone, Colorado. Together, these workshops have been designed to provide the U.S. Department of Energy with a better understanding of barriers, needs, and opportunities for determining the directions and priorities of planned research and development programs in regards to communication and control systems for distributed energy.

Major Findings

Significant communication and control systems issues are associated with the large-scale use of distributed energy devices, particularly if they are to be properly integrated into utility system planning and operations. Products and services from the information technology industries can be utilized to address those issues, including large-scale data management, extraction, and mining tools, distributed programming technologies, and complex data communication systems.

The specific communication and control systems requirements will not be fully known or understood until more experience is gained with actual installations. Electric utilities, distributed energy equipment manufacturers, information technology providers, and customers who will use the distributed energy devices need to work together to find opportunities for expanding installations and designing test procedures to answer critical questions. The U.S. Department of Energy can play an important role by facilitating the exchange of information and co-funding research and development projects in partnership with industry, universities, and the National Laboratories.

Large-Scale Demonstrations

- The primary aim of large-scale demonstrations is to verify and validate a profitable business model(s) for distributed energy systems. This will require comprehensive test procedures and evaluation protocols, including performance measurements, reliability, emissions, operations and maintenance, customer acceptance, and return on investment, all within a variety of locations, technologies, business types, and climate zones. To keep costs down and ensure that the demonstrations achieve their goals, ways must be found to keep the scope focused and the level of complexity of the demonstration project(s) manageable.
- Because large-scale demonstrations need to involve hundreds, if not thousands, of installations, strategies that inspire customers and utilities to participate will be needed. Participation in the demonstrations will likely involve substantial resource and time commitments for customers, utilities, and distributed energy equipment and information technology providers. As a result, innovative financial and cost sharing arrangements for effectively managing financial and technical risks will be needed.
- The implementation and administration logistics of large-scale demonstrations will be time consuming and expensive. Approvals will be needed from a potentially large number of participants and affected stakeholders, including customers, utilities, project developers, financing and insurance organizations, funding organizations, local siting and permitting officials, as well as regional utility groups such as Independent System Operators, and Regional Transmission Organizations. Ways need to be found to streamline procedures and keep overhead costs as low as possible.

Communication and Control System Architecture

- The envisioned communication and control systems architecture can rely on existing communications networks (including existing products for aggregating current distributed energy devices) and involves multiple layers of controls, distributed intelligence, and the ability to respond, in real-time, to changes in market signals and power system conditions. This system architecture needs to exchange physical and financial information and include verifiable accounting procedures for market transactions. The aim is to solve large-scale optimization problems with real-time information, control, and tamper-aware security, privacy, and trust.
- Key architectural design considerations include achieving a proper balance between the need for open protocols, easy access for remote dispatching and diagnostics, and "plug & play" equipment; and the need for effective security of customer facilities and protection of customer privacy and personal/business information.
- Development of national standardized communications protocols for distributed energy systems remains an important step. While much can be accomplished using current communications protocols along existing networks (i.e., telephone lines, wireless systems, and the Internet), interfaces between utility communications systems at the distribution and transmission system levels needs to be developed.

Conclusions

The U.S. Department of Energy should continue working with electric utilities, the distributed energy community, and information technology companies in an effort to advance communication and control systems for distributed energy integration and testing. The Department should also continue collaborations with state agencies such as the California Energy Commission and the New York State Energy Research and Development Agency. Specifically:

- The initial steps in accomplishing large-scale demonstration project(s) include:
  - Evaluating "lessons learned" and "best practices" from related demonstrations in the U.S. and internationally
  - Securing appropriate levels of funding to ensure a successful project(s)
  - Encouraging the formation of integrated project teams with skill mixes that include information and telecommunications systems, distributed energy devices, electric utility operations, and customer-side operations and maintenance

- The initial steps in developing an effective communication and control systems architectural design include:
  - Issuing a competitive solicitation for proposals from industry-university-National Laboratory teams – "A Conceptual Design Competition"
  - Evaluating alternative design concepts and down selecting for the development of at least two prototypes
  - Conducting field tests of the prototypes, perhaps as part of the large-scale demonstration projects

- The initial steps in developing standardized communications protocols for distributed energy systems include:
  - Evaluating existing models, concepts, and templates, and publishing a review paper that outlines the current "baseline" of existing approaches
  - Holding a series of workshops with volunteers from the utility, information technology, and distributed energy industries, perhaps under the auspices of one or more professional societies or trade associations, to outline a process for the development of consensus standards

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Chapter 1
Introduction

There are many unanswered questions and uncertainties about distributed energy resources because the power system is changing and the roles of many of the stakeholders – e.g., regulators, services providers, manufacturers, and utilities – are being re-defined. As a result, there are basic questions about safety, security, reliability, cost, and customer acceptance. While many of the needed technologies exist, there is a lack of technical expertise to get them installed and operating in an efficient and integrated manner. The use of communication and control systems can help answer some of these questions and develop technical knowledge.

To collaborate on some of these questions and determine a path forward, more than 50 experts from energy and information technology industries, Federal and State government agencies, universities, and National Laboratories participated in the "Communication and Control Systems for Distributed Energy Implementation and Testing Workshop" in Reston, Virginia, on May 14-15, 2002. This was a unique workshop in that, for the first time, representatives from the information technology sector and those from energy-related industries, Federal and State government agencies, universities, and National Laboratories, gathered to discuss these issues and develop a set of action-oriented implementation strategies. A planning committee of industry, consultant, and government representatives laid the groundwork for the workshop by identifying key participants and developing an appropriate agenda. ABB, Cinergy Corp., Concurrent Technologies Corp., Energetics, Inc., IBM, The National Renewable Energy Laboratory, Pacific Northwest National Laboratory, and Sixth Dimension Inc. were part of this committee. (A list of all the workshop participants may be found in Appendix A.) This document reflects the ideas and priorities discussed by workshop participants.

The workshop was a follow-up to a Technology Roadmap Workshop on Communication and Control Systems for Distributed Energy Resources held in September 2001 in Keystone, Colorado.[1] The May workshop focused on the two highest priority areas identified at the September workshop: 1) demonstration and testing of communication and control systems for integrating distributed energy resources with grid operation and 2) the system architectures required for communication and control technologies to be intra-operable within distributed energy resources with utility communication and control systems. Following a number of plenary presentations, workshop attendees participated in one of four breakout groups, two working in parallel on demonstration and testing and two working in parallel on system architecture.

[1] The Keystone workshop proceedings may be downloaded at www.eren.doe.gov/der/tech_base/tech_base.html#CC.

Opening Plenary

The workshop opened with a plenary session of remarks and presentations from government officials, industry, and National Laboratory representatives that set the tone for breakout group discussions. A summary may be found in Chapter 2.

Breakout Groups

Immediately following the opening plenary, participants dispersed into their breakout groups to complete a series of four focus questions in their respective tracks. (A workshop agenda may be found in Appendix B.) Chapters 3-6 provide a synopsis of each groups' results.

Demonstration and Testing

The demonstration and testing breakout groups focused on developing ideas for conducting large-scale distributed energy demonstration projects. A large-scale demonstration of integrated distributed energy devices is a venture that will include hundreds, if not thousands, of interconnected distributed generation devices and varying levels of scale-up from components/subsystems integration to facility and utility integration. There are many issues and questions to address in conducting these large-scale demonstrations and using communication and control systems to integrate the devices and allow them to operate seamlessly with the grid.

The demonstration and testing breakout groups discussed the following questions:

- What are the issues, problems, barriers, and concerns associated with conducting large scale demonstrations of distributed energy and communication and control technologies?
- What are the key analysis questions about communication and control systems and distributed energy devices that the proposed demo(s) and test(s) need to answer?
- What should be the design of a distributed energy resources-communication and control demo/test in terms of objectives, locations, number of points, technologies, and applications?
- What is the action plan?

Systems Architecture

The systems architecture breakout groups focused on developing innovative standard information technology architectures that are capable of interoperability and interconnection for distributed energy devices, and buildings, distribution, and transmission systems. Systems architecture provides an overall technical perspective and scope for the distributed energy infrastructure(s) necessary to implement enterprise-wide advanced automation and information technology. Systems architecture integrates the communications, controls, and applications infrastructure with business models and aligns stakeholders' requirements with the applications. It provides a high-level description of a desired infrastructure and is used to provide a common reference for system developers and stakeholders.

The systems architecture breakout groups discussed the following questions:

- What are the communication and control services that need to be provided to distributed energy devices to achieve cost-effective interoperability and integration with utility transmission and distribution systems?
- What are the knowledge gaps that prevent existing communication and control technologies from providing services cost effectively today?
- What should the design of the information technology architecture in terms of key elements, linkages, hierarchies, and communication and control technologies be?
- What is the path forward to developing robust designs for the architecture (action plan)? *And a modified focus question:* What is the action plan to fill the key knowledge gaps so that the architecture requirements can be identified?

Closing Plenary

In the closing plenary session, representatives from each breakout group presented their findings; gaps, cross cutting themes, and paths forward were discussed. Following these summaries, participants were given an opportunity to express final thoughts on the workshop. Chapter 7 contains a summary of the key workshop themes.

Chapter 2
Opening Plenary Session

Welcome and Opening Remarks[2]

William Parks, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy

- Thank you all for coming to this workshop. This is an important program area to us, and I look forward to seeing the outcome of your work.
- The National Transmission Grid Study was recently released, and I encourage you to take a look at it.
- The President's Management Agenda is results-oriented, and we are trying to meet its objectives.

Mark Rawson, California Energy Commission

- At the California Energy Commission, the Distributed Energy Resources Integration Program is a cross-cutting program within the Public Interest Energy Research group that takes a system perspective on distributed energy resources.
- We want to continue building on our successes in improving the interconnection process. Our policy objective has been to level the playing field and ensure safe interconnection.
- We need to determine if distributed energy resources can provide benefits to the grid.
- We want to investigate whether microgrids are a technically and economically feasible way to integrate distributed energy resources into the existing distribution grid, which is not designed for two-way power flows.
- In the mid-term, we want to identify how benefits and impacts of distributed energy resources can be optimized for the grid, end users, California's energy supply, and the environment. To accomplish this, we are doing market analysis to connect our research with the market and involving stakeholders for "reality checks."

Ron Hoffman, Consultant to California Energy Commission

- The demand responsiveness program is just getting underway with two projects starting this summer.

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[2] Copies of the presentations may be obtained by contacting Brian Marchionini at bmarch@energeticsinc.com.

- The first project on baseline studies will attempt to establish how much real-time "automated" demand responsiveness potential there is in large commercial buildings and institutional facilities that have been outfitted with state-of-the-art communications, control, and management/monitoring software.
- The second project on enabling technology development will attempt to develop demand responsiveness -enabling communication and control and other technologies that can reduce installed costs by an order of magnitude. This project will be leveraged by the University of California, Berkeley's Center for Information Technology Research in the Interest of Society
- All of the research and design work will be in the public domain.

Ron Ambrosio, IBM

- Large internet- or enterprise-scale optimization is the value proposition. The physical scale and logical complexity of control systems are increasing.
- Internet-scale requires we do things differently. For instance, we must formalize how we specify control loops and create runtimes that enable a new programming model for complex control systems.
- Large-scale command and control infrastructure will drive business change in the industry. We should be thinking from the top of the business down to better understand and design the technology we need to build.
- Dynamic e-business is driving business processes to be more automated. Process cycles are shortening, and more direct linkage is required between business systems and control systems.
- Control systems are becoming part of the general computing environment; they are increasingly connected to the common network infrastructure.

Bill Randle, American Electric Power

- American Electric Power has several demand response experiences. One example is a residential advanced energy management system that allowed customers to respond to economic signals with the ability to preset actions. The program worked well, and the customers liked it, but the technology was too expensive to buy so it never went to the mass market.
- Another example of demand responsiveness is American Electric Power's customer communication system that serves the largest customers with complex tariffs and contracts. Communication with customers is achieved through a combination of internet, dial-up and dedicated phone lines, pagers and provides 600 MW of demand response. The system works well and is still in service, but is not adding any new customers.
- Here is the key challenge for communication and control: What viable business model exists that encourages the required expense of instrumentation and operation of demand responsiveness assets?

- My recommendation is to provide some focus on developing business models that support long term operation of demand responsiveness assets. Look for lessons learned from utilities, energy information service providers, energy management system providers, customers, etc.

Landis Kannberg, Pacific Northwest National Laboratory

- We are entering tomorrow's complex web of energy transactions and control. Creating ubiquitous communications and information flow and advanced, transactive controls, prognostics, and diagnostics at all levels results in rapid, seamless penetration of distributed energy resources and enhanced stability, security, crisis management.
- The estimated generation deferment from the GridWise program is 55GW by the year 2020.
- There are several systemic benefits of the program: it enables and rewards "services" management to improve the energy system, enables market restructuring with fewer risks and more participants, and creates markets for new services such as aggregation, load ancillary services, interdependency benefits, etc.

Terry Surles, California Energy Commission

- The Public Interest Energy Research program is looking at near-term solutions for California and focusing on end-use and distributed energy solutions.
- We are trying to develop useful building blocks for others to use.
- There are many products that already exist, it's not necessary to reinvent the wheel. A question is, "How do we take advantage of these technologies to move distributed energy resources?"
- The development of national standards is the best way for collaboration.

Chapter 3
Large Scale Demonstration of DER and C&C Technologies
Group A

Barriers, Issues, Problems, and Concerns

Focus Question #1: What are the issues, problems, barriers, and concerns associated with accomplishing large scale demonstrations of distributed energy and communication and control technologies?

The proposed large-scale demonstration projects are complex undertakings. There are many issues to address to get them to work properly. Table 3-1 provides a list of many of the key ones.

There are technical issues to resolve. For example, further progress needs to be made on developing common communications protocols, data structures, and hardware connectivity. While existing communications systems such as the Internet and wireless networks can be used, software needs to be written, and computer equipment needs to be designed and assembled. This poses a "chicken and egg" dilemma: You need an adequate communications and control architecture to operate a large-scale demonstration effectively, but you need a large-scale demonstration to develop information to properly design and calibrate the communications and control architecture.

Group A Participants

NAME	ORGANIZATION
Tom Basso	National Renewable Energy Laboratory
Jack Brouwer	National Fuel Cell Research
David Cohen	Infotility
Dale Dietzel	U.S. Department of Energy, Chicago Operations
Stephanie Hamilton	Southern California Edison
Mike Hoffman	Bonneville Power Administration
Roger Jarmon	Caterpillar, Inc.
Landis Kannberg	Pacific Northwest National Laboratory
John Kueck	Oak Ridge National Laboratory
Tim Ruohoniemi	Honeywell ACS
Wade Troxell	Colorado State University

FACILITATOR: RICH SCHEER, ENERGETICS, INCORPORATED

There are also business issues to resolve. For example, a profitable business model for distributed energy systems needs to be firmly established. There is a need for "capturable" value streams for the full range of potential benefits – e.g., power quality, reliability, security, peak load management, energy savings, costs savings, and emissions reductions. These value streams need to be able to flow through the entire system from generator to customer and ways need to be found to make them visible to power system operators on local and regional levels.

There are demonstration project design issues to resolve. For example, ways need to be found to ensure that the results are replicable and scalable. The dissemination of knowledge of results is one of the key design factors. Ways need to be found to resist the tendency to accomplish too much and to dilute focus with multiple and conflicting goals. For the demonstration to be successful, it must occur in real world settings and operating conditions. As a result, the demonstration needs to involve more than tests of equipment performance. It also requires identifying "agreeable" utilities and customers to participate.

Finding interested utilities is made difficult by the lack of existing tariffs or programs for distributed energy. There are certain utilities in certain states with interest and relevant activities underway, but this sample might be too limited to accomplish the goals. Finding interested customers will probably require contracts and incentive payments that do not yet exist.

Desired Outcomes

Focus Question #2: What are the key analysis questions about communication and control systems and distributed energy devices that the proposed demo(s) and test(s) need to answer?

There are many questions for which the proposed large-scale demonstrations need to be designed to answer. Without careful planning it will be difficult to ensure that the desired outcomes of the demonstrations are achieved. Table 3-2 lists many of the key desired outcomes.

First and foremost, the demonstration must be able to validate profitable business models and value propositions for distributed energy. The demonstration needs to show that utilities, customers, manufacturers, and services providers can all benefit. Means must be found to disseminate findings on these topics to all relevant stakeholders including federal, state, and local energy and environmental policy officials and interest groups.

To do this, the demonstrations must be able to establish the performance of distributed energy systems in terms of economics, reliability, power quality, emissions, security, safety, and controllability. The demonstrations must include development of both baseline data and test results under a wide variety of conditions and circumstances.

It is important that regional and national organizations be aware of the demonstrations and participate in their planning and implementation. Groups such as the Federal Energy Regulatory Commission, National Association of Regulatory Utility Commissioners, and the regional transmission organizations need to be contacted and involved in the process. This will help in the national dissemination of the results and in ensuring that the potential benefits to transmission congestion are established.

The demonstrations should be showcases for validating the performance of alternative communications and control system architectures and the basis for the development of standard protocols and operating procedures. A better understanding should be achieved of remaining knowledge gaps and technology needs. Customer acceptance should be addressed.

Demonstration Project Designs

Focus Question #3: What would be your proposed design of a distributed energy resources-communication and control demo/test in terms of objectives, locations, number of points, technologies, and applications?

Table 3-4 provides three alternative designs for large-scale demonstrations of distributed energy and communications and control technologies. The alternatives have similarities and differences. Each offers a fundamental change from current practices. Each emphasizes the need to validate profitable business models along with devices, systems, and architectures. Each seeks to make maximum use of existing installations.

Paths Forward

Focus Question #4: What is the path forward to implementation (action plan)?

There are a number of steps to move forward with the demonstrations. Table 3-5 outlines three key actions: 1) Prepare a document to justify the need for the demonstrations projects; 2) launch a focused industry-led effort to identify sources of funding from federal, regional, and state authorities; and 3) issue a competitive solicitation for the formation of teams to conduct at least the first phase of multi-phase demonstration projects.

TABLE 3-1. LIST OF BARRIERS, ISSUES, PROBLEMS, AND CONCERNS

♦ = NUMBER OF VOTES RECEIVED FOR TOP PRIORITY SHOWN

RESOLVING TECHNICAL ISSUES	RESOLVING BUSINESS ISSUES	RESOLVING DEMONSTRATION DESIGN ISSUES	MAKING UTILITIES COMFORTABLE	FINDING AGREEABLE CUSTOMERS	FINDING ENTHUSIASTIC SUPPLIERS	FINDING COOPERATIVE LOCAL JURISDICTIONS
• Common communication protocols, data structures, and hardware connectivity ♦♦♦♦♦♦♦♦ – Open internet protocols – Industry standards • Open system architecture that handles security and dynamic operations ♦♦♦♦♦ • Proven capabilities to operate under extreme conditions ♦♦♦ • Uniform utility interconnection standards ♦ • Validated data on distribution grid impacts • Validated baseline data on power quality levels and events • Scalable control algorithms for disparate devices and systems	• Market visibility across stakeholders for pricing, ancillary services, emissions aspects of DER and C&C ♦♦♦♦♦♦ – Need for profitable business case – Credible market potential study to arouse interest and justify investments • Clear linkages from retail to wholesale markets ♦♦♦♦ – FERC awareness/ oversight – Hard to “break into” RTO or ISO world • Uncertainty of overall DER opportunity will result in withholding of resource commitments ♦ • Standard agreements and contract mechanisms for demonstrations (e.g., what happens to equipment after the demo is done?)	• Results must be replicable and scalable ♦♦♦♦ – Dissemination of knowledge is key • Need way to avoid “X-Mas Tree” effect of trying to accomplish too much ♦♦♦ • Capture “real world” environment of dealing with diverse capacity factors and load factors ♦♦♦ – Prove benefits of DER paradigm e.g. PQ, stability, aggregation, peak load reduction – Interaction with customer loads – Stand alone operations • Hard to capture elusive multi-dimensional values and benefits ♦ • Hard to get detailed analysis of distribution level data	• Few utilities with existing programs/tariffs in which to make good use of DER systems ♦♦♦♦♦♦ – Revenue protection concerns – Lack of in place contract rates and relationships • Questions about grid stability with large scale DER deployments ♦ • Need for software to schedule operations and dispatch ♦ • Prove value to utilities ♦ – Need for marketing materials showing DER value to distribution utilities • Uncertainties about safety ♦	• Incentives package for gaining customer interest – Payments or other benefits to customers • Customer concerns about data privacy/security • CHP installations have many benefits but hard to retrofit on existing buildings • Easy, simple contracting mechanisms	• May have to provide customized hardware software at the start	• Addressing needs of local sitting and permitting officials

TABLE 3-2. LIST OF DESIRED OUTCOMES

♦ = Number Of Votes Received For Top Priority Shown

SUBGROUP #1	SUBGROUP #2	SUBGROUP #3
• Performance comparisons versus baseline ♦♦♦♦ – Economics – Reliability – Power quality – Controllability – Emissions – Security • Better understanding of actual opportunities and benefits ♦♦♦ • National focus and great overall public understanding of DER and benefits ♦♦♦ • Better understanding of remaining knowledge/technology gaps ♦♦ – Technologies – Value proposition – Policies • Proof that large- scale systems are greater than the sum of its parts ♦♦ • Proof of concept for C&C systems ♦ – Scalability – Flexibility – Interoperability • Significant depth and breadth of stakeholder commitment and involvement ♦ • Process for peer review and validation of results • Performance standards for data communications between devices	• Validate profitable business model and value propositions ♦♦♦♦♦♦♦♦♦ – Benefit discovery and validation – Dissemination to stakeholders – Mechanisms for keeping customers involved after demo is complete • Establish communications and controls requirements – technical, business, and regulatory ♦♦♦ • Assessment of privacy and security requirements ♦♦♦ • Establish operations and operability ♦♦ • Evaluations of architecture alternatives ♦♦ • Inventory of technology (DER and C&C) performance attributes and data ♦	• FERC, NARUC, and RTOs/ISOs involvement in the demo ♦♦♦♦♦♦ – Planning – Data analysis – Standards setting • Establish “model” program design and tariff for utilities to use in valuing energy, capacity, and congestion relief ♦♦♦ • Replicability – bracket a range of conditions ♦♦ – Achieve 90% of applications/situations with limited number of tests/sites • Evaluations of the relative merits of various DER and C&C technologies • Cost versus return on investment scenarios – Urban versus rural – Scalability – Determine cost minimums that systems have to meet • Establish viable communications and control architecture(s)

TABLE 3-3. PROPOSED DEMONSTRATION PROJECT DESIGNS

NAME "TAG LINE"	BRIEF DESCRIPTION	OBJECTIVES	APPLICATIONS	TECHNOLOGIES	LOCATIONS	NUMBER OF POINTS
"DERNET" – the ARPANET of DER	• Regional (not national) • Variety of devices • Peer-to-peer networking (not SCADA) • Economic transactions to set prices • Standard data models of availability, capacity, load forecasts, and costs • Infrastructure to support a variety of tests • Involve a variety of industrial and commercial customers and at least two utilities and national labs	• Networking of heterogeneous devices (e.g., gensets, storage, meters, power electronics) • Testbed for applications development • Prove performance versus baseline • Develop interoperability standards	• Grid stability • Security models • Congestion relief • Power quality • Load management • Emissions studies	• Low-cost gateways • Distributed controls • Agent-based optimization • Communications protocols/standards	• Existing DER assets • T&D constraints • Amenable utilities	• 1K power sources • 1K loads (meters)
"ADEPT" – Alliance for Distributed Energy Performance Test	• Several diverse sites • 70% of full technology suite at each site • Business model varieties • ESCOs • Utilities • Regulators • RTOs/ISOs • Manufacturers, architects, and engineering • Local agencies/groups	• Technical performance • Customer acceptance • Business model validation • Definition of deployment plans	• T&D congestion • Protection conditions • Load criticality	• All types of DER • CHP • Storage • Load management • DC systems • Control options (agents, hierarchical) • Business decision processes (EDI) and architecture	• Congested areas • High value loads • Rural, urban, and suburban • Diverse fuel sources • Weather	• 40% of load • Enough to be compelling and convincing
Proving the Value	• Two large-scale test	• Validate business models • Significant penetrations • FERC, NERC, RTO/ISO, utility involvement • Deferral of rural feeder upgrades • Improve substation operations • Emissions • Smart metering • Innovate tariff/program designs • "Chips talking to Chips"	• Islanding • Power Quality • CHP • Peak shaving • Voltage/VAR regulation • 3-5 year deferral on feeders • Market volatility	• Fuel cells • PV • Wind • Microturbines • Storage • Recip engines • Load management	• Urban and rural	• At least 120 • ~$25 million

TABLE 3-4. ACTIONS AND PLANS

ACTION	BRIEF DESCRIPTION OF SCOPE	MILESTONES	PARTNERS AND ROLES	IMMEDIATE NEXT STEPS
Prepare report that justifies the need – "Roadmap for Large-Scale DER Demo"	• Establish the baseline - document existing demos in U.S. and globally; available technologies; existing demo plans • Establish the rationale – economic, social, regulatory, technical; set demo goals and objectives	• Survey existing baseline (3 months) • Draft report (6 months) • Peer review • Final (10 months)	• U.S. DOE funds study • Data gathered from utilities, manufacturers, national labs, universities	• Issue solicitation • Award contract
Solicit funding from a variety of sources – "Achieving the Technology Edge…Providing the Financial Hedge" or "Disaster Relief for Utility Restructuring	• Develop solicitation package • Engage key stakeholders • Mobilize for discussions with private and federal, state, and regional funding sources	• Briefing package to key stakeholders (6 months) • Outreach campaign to Congress and state legislatures (6-12 months) • Repeat yearly	• Private industry leads – utilities, manufacturers, customers, etc.	• Briefing package • Hold discussions at upcoming DER conferences/workshops
Issue competitive solicitation for the creation of DER Demo consortia consisting of implementation teams	• Multiple teams • Each to contain broad regional support • Each shall focus on its demo • Cost sharing required	• Issue solicitation (ASAP) • Award contract to winning teams – multi-year plans/funding (over next 6 years) • Conceptual designs (1st phase) • Down select, maybe • Independent peer reviews • Sharing of best practices	• Regulatory approvals (FERC, RTO, PUCs, local inspectors and code officials) • U.S. DOE funding • Industry cost share (utilities, manufacturers, vendors) • Customers • Labs, universities, contractors	• Issue solicitation • Include funding for Phase 1 – feasibility/conceptual design • Gain high level commitment from key team members

Chapter 4
Large Scale Demonstration of DER and C&C Technologies
Group B

Barriers, Issues, Problems, and Concerns

Focus Question #1: What are the issues, problems, barriers, and concerns associated with accomplishing large scale demonstrations of distributed energy and communication and control technologies?

Large-scale communications and controls demonstration projects require attention to a number of important issues. Table 4-1 provides a list of the key issues.

Economics and business issues are the most critical barriers facing implementation of demonstration projects. There are no clear market mechanics that support deployment. Questions related to the cost of distribution system upgrades, particularly for small-scale systems, continue to be raised. In addition, the risks inherent in communications and controls systems must be equitable apportioned to the various parties participating in demonstration projects. Target utility companies, as well as other stakeholders, need to be convinced that there is a financial, as well as policy, benefit to participating in demonstration projects. Utility opinions about distributed energy resources technologies and systems, risk, incentives, etc. vary throughout the country, requiring attention to pre-conceptions during the planning and management process.

Group B Participants

Name	Organization
SK Chauhan	Utility Automation Integrators
Kirk Hanlin	Utility Automation Integrators
Satish Kumar	Lawrence Berkeley National Labs
Harold Lampe	AEP
Mark Lively	Utility Economic Engineers
John Petze	Tridium
Bill Randle	AEP
Mark Rawson	California Energy Commission
Steve Rivkin	Attorney at Law
Larry Simpson	Connected Energy
Mike Warwick	Pacific Northwest Labs
Robert Wills	Advanced Energy

Facilitator: Jan Brinch, Energetics, Incorporated

Program design and management is another major issue standing in the way of large-scale demonstration projects. Attention must be paid to the selection criteria applied to such projects. Such criteria include the size, location, and number of participants; the appropriate length of the demonstration project to justify customer investment in technology (Return on Investment – ROI); the economic and technical feasibility of the communication and control technologies and distributed energy resources system which the demonstration project is designed to address; standard protocols across programs; openness and scalability; and the need for real world – not academic – demonstrations. Other program design and management issues include appropriate monitoring and evaluation procedures; risk assessment procedures that address regulatory, consumer, safety, reliability, and grid design concerns; and funding mechanisms.

For a large-scale demonstration to be installed, monitored, and evaluated accurately, technical and information systems need to be integrated with the energy system. Building controls, demand side management controls and systems, and information technology systems all need to be integrated. These controls and systems are expensive and can be complicated, requiring personnel, hardware, and software to operate efficiently, securely, and safely.

Legal, regulatory and institutional issues often stand in the way of successful demonstration projects. Meeting federal, state, and local regulatory requirements, local building codes and standards, and various institutional requirements such as air emission standards can affect both the financial and energy attractiveness of such projects. New, or unproven, concepts require that even more hurdles are overcome, causing time delays and higher costs. These issues, while not necessarily insurmountable, must be addressed.

Desired Outcomes

Focus Question #2: What are the key analysis questions about communication and control systems and distributed energy devices that the proposed demo(s) and test(s) need to answer?

A number of key outcomes and analysis questions need to be addressed by the large-scale demonstrations. They include technology issues and protocols, economics and business questions, stakeholder issues, legal, regulatory, and institutional issues, and program design and management concerns (see Table 4-2).

The impact of distributed energy resources and communications and controls technologies on the utility distribution system needs to be assessed. How reliable are these technologies? How safe are they? What is the cost and return on investment? What do they do to power quality? What is the impact of communication and control designs on the peak load? On bi-directional flow? How are integration issues handled? What changes need to be made on the power plan and equipment? Technology gaps need to be closed, requiring attention and the design of specific protocols.

The value of distributed energy resources and communication and control equipment and systems to consumers, utilities, and other stakeholders needs to be defined and quantified. Large scale demonstration projects will require a financial and personal commitment from stakeholders at each site, or node, in the demonstration system. The implications of distributed energy resources on both utility and non-utility participants in a demonstration project in terms of ownership need to be explored (Who owns the lines? Who owns the switching equipment?). Utility companies must be brought into demonstration projects at the planning stage, so that their commitment is secured and any problems are raised early in the process.

Large scale demonstrations of communication and control technologies must include identification of economic and business ramifications, to both stakeholders in the utility generation and transmission and distribution system as well as distributed energy resources designers and policy makers. The efficacy of different pricing structures for distributed energy resources systems, including the effect of distributed energy resources on various settlement periods, must be analyzed through the demonstration process. In the end, the cost-effectiveness of distributed energy resources technologies and communication and control equipment and systems should be a major goal of large-scale demonstrations.

In the legal, regulatory, and institutional arena, a regulatory "template" for national and state adoption of distributed energy resources needs to be developed. Such a template would reduce the time and financial inputs for siting, permitting, and regulating distributed energy resources systems "from scratch." A template that provides policy makers with the information they need to streamline such systems (e.g., air permitting requirements, water quality permitting requirements, land use issues, fire and safety codes, etc.) would reduce the transaction time from planning to implementation and improve distributed energy resource cost-effectiveness.

A number of program design and management questions also need to be answered through large-scale demonstrations. The demonstrations should define and validate site characteristics, the size and capacity of devices, geography issues, data points and control parameters needed, the applicability of standards, and the viability of the Internet for technical information gathering and dissemination, data tracking and retrieval, and communications among distributed energy resources users.

Demonstration Project Designs

Focus Question #3: What would be your proposed design of a distributed energy resources –communication and control demo/test in terms of objectives, locations, number of points, technologies, and applications?

Table 4-3 provides four alternative designs for large-scale demonstrations of distributed energy and communications and controls technologies systems. The four include:

- Assessment of the impact of distributed energy resources on the national utility distribution system
- Analyze the effectiveness of different business models on distributed energy systems
- Identify the value proposition of existing and proposed distributed energy resources sites on the grid
- Develop a standard communications and control protocol

Each involves an analysis of the cost-effectiveness of distributed energy resources and its use in the transmission and distribution system as it currently exists in this country. Each involves stakeholders at an early stage in the process. Each requires diversity in location, climate, customer classes, and technology. And each involves variety in terms of the energy source (prime mover).

Paths Forward

Focus Question #4: What is the path forward to implementation (action plan)?

A number of paths are required to move ahead with large-scale demonstration of distributed energy resources and communication and control technologies and systems. Table 4-4 outlines three key actions:

- Scope the project to determine its economics, stakeholders/involved parties, objectives, distributed energy resources products, etc.
- Engage key stakeholders in the planning and implementation of the demonstration project(s)
- Develop an econometric model of distributed energy resources costs and benefits

Table 4-1. List of Barriers, Issues, Problems, and Concerns

— = Indicates The Number Of Votes Received

Legal, Regulatory and Institutional Issues	Program Design and Management	Technology Hardware	Economics–Finance Business
• Regulatory alignment ♦♦♦ – Traditional price regulation (PUCs) • Getting regulatory leeway to demonstrate novel concepts (e.g., RTP, grid benefit tariffs, utility/customer ownership, etc.) ♦♦♦ • "Consortium" putting different vendors together to achieve a common goal ♦ • Public access to data ♦	• Selection criteria ♦♦♦♦♦♦♦♦♦ – Determining size, location, participants – Creating long enough demonstration to justify customer investment in technology (ROI) – Structuring demonstration to address economic and technical feasibility of C&C technologies and DER – Standard protocol across programs – Real world demonstration–Not academic – Openness and scaleability • Evaluation Criteria ♦♦♦♦ – Determine how we monitor and evaluate demonstration – Regulated vs. unregulated utilities • Risk (formal) assessment ♦♦♦♦ – Regulatory – Consumer – Network safety – Human safety – Network reliability – Risk of bad technology, bad business model, bad luck – Grid design impacts • Funding and incentives ♦♦ – Where $ comes from – Incentives for part – Funding and incentivizing collaboration with distributed generation installations	• Information technology issues–infrastructure ♦♦♦♦♦♦♦♦ – Integration of building controls and DSM – Is optic fiber optimum physical medium? – Can consumer computer/IT drive deployment? – Can we use the internet? • Low cost per node/customer ♦♦ • Standard, open communications protocol ♦♦ • Demonstrate aggregation of smaller distributed generation ♦ • Security—how do we keep this secure? ♦	• There are no clear market mechanics that support economics of deployment, i.e., who champions and why? ♦♦♦♦♦♦♦♦♦♦♦ – Time invariant prices – Cost for distribution system upgrade who will bear the cost–small IPP's cannot afford to bear cost of upgrading distribution system – Environmental benefit – Pricing reactive power – Economic seams poorly managed – Value proposition and risk apportionment to the parties – What is the benefit for the target utility area & why would they choose to participate in the demonstration? – Balkanization of benefits (Who wins? Who pays? How?) • Diversity of utility opinions ♦♦♦ – Build on utility support – Understand utility risk – Understand various utility technologies – Show that demonstration effort will be appositive – Need for utility incentives • Open protocol business issue ♦♦ • Can management of distributed energy and demand response share networks with other pubic uses? ♦ • Bringing together parties with money to fund it ♦ • Market objectives • Identifying a way for the demonstration to be profitable

TABLE 4-2. LIST OF DESIRED OUTCOMES

— = INDICATES THE NUMBER OF VOTES RECEIVED

<table>
<tr><th>ECONOMICS AND BUSINESS $</th><th>TECHNOLOGY ISSUES/PROTOCOLS</th><th>STAKEHOLDER ISSUES</th><th>LEGAL, REGULATORY AND INSTITUTIONAL ISSUES</th><th>PROGRAM DESIGN AND MANAGEMENT</th></tr>
<tr>
<td>• Economic and business model(s) identification
♦♦♦♦♦♦
– Based on hard data
• Efficacy of different pricing structures
♦♦♦♦
– Effect of different settlement periods
• Cost-effectiveness of DER technologies (C&C included)
♦♦♦</td>
<td>• Assess impact on distribution system
♦♦♦♦♦♦♦
– Reliability
– Safety
– Cost (capital and opn)
– Power quality
– Design impact
— Peak sizing
— Bidirectional flow
– Integration issues
– Changes in plant and equipment
• Identify technology gaps–ongoing work
♦♦♦
• Standard, open secure, scalable comm. protocol
♦♦♦</td>
<td>• Define and validate: value proposition for various participant cost per site
♦♦♦♦♦♦♦
– Identify consumer roles, responsibilities, issues
• Effect of distributed generation ownership utility vs. nonutility
♦♦♦♦
• Successful engagement of utility with defined process for siting a DER deployment
♦
• Education for different audiences
♦</td>
<td>• Regulatory template for national/state adoption
♦♦♦♦
– Includes risk assessment
• Successful engagement of PUC's with case study model and lessons learned</td>
<td>• Define and validate:
♦
– Selection criteria
– Site characteristics
– Size and capacity of devices
– Geography issues
• Define and Validate:
♦
– Data points and control parameters needed
– Applicability of standards
– Viability of internet</td>
</tr>
</table>

TABLE 4-3. PROPOSED DEMONSTRATION PROJECT DESIGNS

DEMONSTRATION/TEST DESCRIPTION	OBJECTIVES	LOCATIONS	NUMBER OF POINTS	APPLICATIONS
• Assess impact on distribution system – Numeric models – Lab testing – Field tests	• Measure and assess – Reliability – Safety – Cost (capital, O&M) – PQ – Design impact — Peak sizing — Bid rectional flow – Integration issues – Changes in plant and equipment – Upstream environmental issues • Establish critical penetration levels - “tipping point” • Schedule – Prioritize – Timeliness–results in 1-2 years	• Diversity: – Metro – Suburban – Rural – Network – Radial and radial-loped – Radial • Geographic – Climate – Lighting – 3 wire (CA vs. 4 wire (NE))	• Range of penetration – % of rated peak load of CCT – Low, medium, high – Total number of points is a function of locations and percent of load and distribution system configuration	• Wide range of DER – Inverter-based – Rotating machines – Storage • Demand response and load control
• Effectiveness of different business models	• Determine impact of business models on DER – Economic model risk assessment regulatory bar field validation	• MUNIS –- 2 • Coops – 1 • Fed – 1 • Tribe – 1 • IOU – 5	• Combinational analyses – 10 customers per 10 – 3 DER owners - 30 – 4 pricing structures 120 – 2 communication costs - 240	• Utility ownership (MUNI, Coop, Fed, Tribe, IOU) • DER ownership (utility, customer, 3rd party) • Pricing structure/shared communication infrastructure
• Include existing sites and Greenfields • All units dispatchable • Grid connected • All data available and normalized	• Identify value property for various stakeholders: asset owners, energy consumer dispatch service providers and utilities – Support multiple business models as to asset/power ownership – Involve multiple DER devices, capture capital and O&M costs	• ≥ 50 sites • ≥ 5 customer types	• Points minimum: – Load – Efficiency of asset – Pricing (location specific) – Run hours profile – Local weather – Facility dependent load conditions – Event log	• Storage • CHP • Generation (multi-types) • Reactive support/PQ • Peak shaving
• Standard communications protocols	• Measure: – Cost – Reliability – Ease of use – Speed – Responsiveness – Accuracy – Multiple manufacturers – “Interoperability”	• Same	• A/ Small demo • B/ Large (traffic implications)	• Same

TABLE 4-4. ACTIONS AND PLANS

— = NUMBER OF VOTES RECEIVED FOR TOP PRIORITY SHOWN

KEY ACTIONS	BRIEF DESCRIPTION (SCOPE)	MILESTONES/ DATES	PARTNERS/ROLES	IMMEDIATE NEXT STEPS
• Scope the project ♦♦♦♦ – Economic thesis – Players – Objectives. – Define DER products–energy, reserves, demand relief, etc.	• Define different markets (customers) and economic models to demonstrate (End users, ESCOs, . . .) • Define: – Objectives – Success Metrics – Stakeholders	• 6 months	• Lead: DOE • Stakeholders: FERC, NARUC, PUCs, Utilities, IPPs, ESCOs customers, Labs, state R&D, O&Ms/vendors – Willingness to cost-share/provide in-kind support to demonstration projects	• Identify project manager (DOE) • Assemble stakeholders • Scope demonstrations
• Engage key stakeholders in demonstration process/ program description ♦♦♦♦♦♦♦♦ – Regulators – Utilities – Customers – Vendors – Push FERC to adopt seamless management pricing (standard offer) – Develop test plan for grid effects assessment	• Gain support for the demonstration process	• 6 months	• DOE ♦ – FERC – NARUC – PUC/Demonstration – Utilities – RTO/ISO – End User groups – Institutional – Environmental – Vendors–GAO – Public Policy Organizations – Identify progressive states–Limited number of geographic areas • Institutional, environmental vendors ,and public policy organizations • Identify progressive states–Limited number of geographic areas	• DOE Lead • Identify invitees; develop stakeholder group • Draft/send invitation letter • Develop communication strategy (website, PR, etc.)
• Develop an econometric model of DER costs and benefits ♦♦♦♦♦♦ • Develop test plan for grid effects assessment ♦♦♦ • Standard R&D protocols for interconnections ♦♦♦ • Create supportive regulatory and pricing environment to support private sector market forces	• Define costs and benefits for each DER technology and for the C&C system • Costs: – Installation and regulatory O&M (includes fuel cost and efficiency) • Benefits: – Energy value by location and time – Availability – Reliability – Security – Environmental – Transmission & Distribution • Define Options: – Public policy – Funding – Business models	• 6 months	• DOE (funding) • National labs, academia, consultants • Utilities • Manufacturers and vendors	• Develop requirements • DOE solicitation

Chapter 5
Systems Architecture
Group A

C&C Services

Focus Question #1: What are the communication and control services that need to be provided to distributed energy devices to achieve cost-effective interoperability and integration with utility transmission and distribution systems?

To be effective, communication and control services will have to include a secure, standardized, Internet enabled, two-way communications infrastructure. Public and private communications networks need to overlap, but privacy and safety need to be maintained. Table 5-1 identifies some additional services.

The control and information system will need to support the existing transmission and distribution legacy. It should have an open architecture and be able to support Java, XML, and HTML. Both object models and interaction procedures should be standardized. Standards development should be coordinated among government, industry and standards groups.

Communication and control services need to include algorithms that will allow distributed energy resources to be incorporated into distribution automation, provide measurable cost benefits, and serve as a platform for services that will be needed in the future.

Group A Participants

NAME	ORGANIZATION
Abbas Akhil	Sandia National Laboratories
Rick Allison	Enercon Engineering, Inc.
Ron Ambrosio	IBM Research
Phil Bomrad	Tridium, Inc.
Sunil Cherian	Sixth Dimension
Frances Cleveland	Utility Consulting International
Dick DeBlasio	National Renewable Energy Laboratory
Paul Duncan	Airak, Inc.
Gregg Ehlers	Invensys Home Controls
Marc Fioravanti	Envenergy
N. Richard Friedman	Resource Dynamics Corp.
Frank Goodman	Electric Power Research Institute
Ron Hofmann	RHC (PIER/CEC)
Ali Ipakchi	Alstom ESCA
Robert Morgan	United Technologies
Paul Sheaffer	Resource Dynamics Corp.

FACILITATOR: ED SKOLNIK, ENERGETICS, INCORPORATED

Knowledge Gaps

Focus Question #2: What are the knowledge gaps that prevent existing communication and control technologies from providing services cost effectively today?

The gaps that hamper communication and control services today are conceptual, regulatory, economic, and technological in nature. These gaps are interrelated and time dependent. That is, knowledge gaps of a conceptual nature need to be removed initially. How will distributed energy resources integrate with distributed automation? How do we define the distributed energy resources marketplace?

Once the role of distributed energy resources in the communication and control arena is identified, one can then concentrate on the regulatory and economic gaps. These two areas provide gaps that are iterative in nature. Removal of any regulatory gaps needs to consider economics, and vice versa. To speak to regulatory gaps, one must address the lack of standards involving protocols, data requirements, and the level of control. The uncertainties that will develop from re-regulation must be considered as well. Economic issues will involve the cost/benefit of change as it applies to different distributed energy resources business models and will also concern economies of scale requirements.

It is only when these knowledge gaps have been eliminated that the important technical gaps can be adequately addressed. Foremost among these gaps is the lack of technical standards. There is also a need for the transition of proprietary systems to an open architecture while ensuring that security is built in as part of the architecture, not as an add-on. Table 5-2 shows the complete list of knowledge gaps.

Conceptual Designs of Proposed IT Architecture

Focus Question #3: What is your proposed design of the Information Technology in terms of key elements, linkages, hierarchies, and communication and control technologies?

With the abovementioned knowledge gaps, especially involving the definition of a distributed energy resources role, designing a realistic information technology architecture is likely impossible. That caveat must be invoked before reading this section on architecture design. Three architectures are discussed in that light. See Table 5-3 for a detailed list of the designs.

Design #1: Distributed, Intelligent Architecture

This architecture is based on the inclusion of several intelligent devices in the electricity supply/demand chain. These devices will allow the architecture to support multiple business models, applications, and time-scales. The system will be more scaleable, more secure, self-healing and self-organizing. Intelligent devices will create a lower risk to overall system reliability.

Design #2: Resources Allocation and Leveraged Power Handling System

This architecture will provide two-way command and control of distributed resources including generation, load, and energy storage. Incorporating modeling, software, and sensor technologies, this architecture will process both digital and analog data. It will consider resource availability and be able to curtail either production or load if necessary, based on capacity. It will also provide distributed energy resources power quality support.

Design #3: Integrated Control Domain Architecture

This system consists of multiple, overlapping control domains, each with its own optimization priorities. These domains, using regulatory "control points," operate together to optimize the overall system, including market operation, security, environmental management and resource management. The design is based on control models, distributed control model runtime, and secure authentication and trust architecture.

Paths Forward

(Modified) Focus Question #4: What is the action plan to fill the key knowledge gaps so that the architecture requirements can be identified?

As stated above, an action plan for developing architectures should be preceded by first addressing the conceptual, regulatory, and economic knowledge gaps, also delineated earlier. In this section, the action plans for bridging these gaps, not for developing the architectures, are discussed. Table 5-4 shows the complete list of ideas.

Action Plan #1: Communication and Control Business Case – A Stake in the Ground to Define the Distributed Energy Resources Marketplace

This plan attempts to remove conceptual knowledge gaps by defining the distributed energy resources role. This involves developing a conceptual model for the distributed energy resources marketplace and defining its value chain and stakeholders. The model should be reiteratively refined and reevaluated. After working with regulatory bodies and stakeholders, new regulations should be implemented.

The conceptual model should be developed by 2003, earlier if possible. Refinement and regulatory actions should occur over the 2004-2005 timeframe. The U.S. Department of Energy would lead the model development, and industry would develop and implement the technologies and systems in parallel. The budget planning process should start as soon as possible.

Action Plan #2: Standardization of C&C

This plan will aid the effort to develop a national communication and control system by focusing on the standardization of key specific areas. A national communication and control system and the requirement of these standards should be mandated by the government. It will be necessary to work with Congress for this to happen. Meanwhile, industry will define the specific areas for standardization and work with the government and the regulatory agencies to have the standards defined, developed, and adopted. This plan should commence following the initiation of Action Plan #1. A joint government/industry team to develop standards should be formed; industry should begin to work with government concerning the requirement for standards.

Action Plan #3: Creation and Validation of Value Propositions

This economic-based plan completes the trilogy of conceptual, regulatory, and economic steps necessary to lead to the development of an architectural pathway. Working through models, real world validations, analyses, and iterative modifications, this plan will determine and validate necessary economic implementation strategies. This process will be run in parallel with the regulatory Action Plan. It will involve input from government as well as industry sectors (utility, commercial, industry, residential), and will also involve national laboratories and universities to develop market models and scaling options. The Federal government should issue a competitive solicitation and funding set-aside.

TABLE 5-1. C&C SERVICES

♦ = Number Of Votes Received For Top Priority Shown

COMMUNICATION INFRASTRUCTURE (TRANSPORT)	OPERATIONS/ APPLICATIONS/BUSINESS	CONTROL/INFORMATION MODELS (APPLICATIONS)	PROCEDURES FOR DEVELOPMENT OF STANDARDS AND ARCHITECTURE
Security of communications ♦♦♦♦♦♦	Algorithms for incorporating DER into Distribution Automation (DA) ♦♦♦♦♦♦	Support for legacy T&D systems ♦♦♦♦♦♦♦♦♦	Coordination and teamwork • Government • Industry • Standards groups ♦♦♦♦♦♦
Standard communications protocol • Internet enabled ♦♦♦♦♦	Measurable cost-benefit ♦♦♦♦♦	Communications architecture • Object models • Protocols (Open architecture) • Java, XML,HTML ♦♦♦♦♦♦	Validation and certification of equipment conformance to architecture ♦
Use of overlapping public and private communications networks ♦♦♦	Platform for future applications and services ♦♦♦♦	Standard object models (“nouns”) ♦	
Communications infrastructure integrity • Recovery • Reconfiguration • Autonomy ♦♦	DER as part of bigger picture in DA evolution ♦♦♦	Standard interaction procedures (“verbs”) ♦	
Authentication and Trust: Addresses privacy and safety ♦	Software development tools • Facilitate integrated business and operation control applications ♦♦	Common interface and communications for substation and DG/load equipment	
Always on high speed secure network	Ease of installation ♦	Multi-protocol devices (IEDs) instead of single protocol IEDs	
Two-way communication	Low-cost installation and maintenance ♦	Standard data requirements (per type)	
Measurement and verification data	Leverage large-scale data modeling and analysis technique. “Globally” optimize ♦		
	State of availability of resources (ready for use)		
	Ability to subscribe to services from various service providers		
	Ability to distribute business logic between service provider and service subscriber		

TABLE 5-1. C&C SERVICES

♦ = Number Of Votes Received For Top Priority Shown

COMMUNICATION INFRASTRUCTURE (TRANSPORT)	OPERATIONS/ APPLICATIONS/BUSINESS	CONTROL/INFORMATION MODELS (APPLICATIONS)	PROCEDURES FOR DEVELOPMENT OF STANDARDS AND ARCHITECTURE
	Low-power consumption device		
	Current and predicted energy costs		
	Device should have the ability to negotiate and provide services (safety, testing, etc.) back to service provider		
	Support/interoperate with other services (maintenance, operation) that remote equipment needs.		
	Provide value-added capabilities • Price signals • Maintenance automation • Monitoring		

Table 5-2. Knowledge Gaps

♦ = Number Of Votes Received For Top Priority Shown

Conceptual	Regulatory	Economic	Technological
Lack of integration vision for DER with DA ♦♦♦♦♦♦♦♦	Regulatory treatment gap • State • Federal • Environmental (Uncertainties of re-regulation) ♦♦♦♦♦	Value propositions for different DER business models • Cost-benefit of change? ♦♦♦♦♦♦♦♦	Standards gap (technical) ♦♦♦♦♦
Lack of a “stake in the ground” ♦♦♦♦♦♦	Lack of standards • Protocols • Data requirements • Level of control ♦♦♦♦	Economies of scale requirements ♦♦♦♦	Migrating proprietary systems to open architecture with legacy adapters ♦♦♦♦
Lack of applications to model, manage and optimize distribution systems with DER ♦♦	Too many “sacred cows” (inertia) ♦	How to share system-wide benefits to overcome economic and psychological barriers ♦	Security as part of architecture and not an add-on • Economic implementation of security on public networks ♦♦♦♦
How to educate utilities in accepting changes in technology		Lack of models for potential operations/ coordination	Converting data into information ♦♦
Vision of where DG is in the future of T&D			Currently, we have a customized, not a standardized, SCADA interface ♦
How do environmental factors relate to DER concept?			Lack of communications network that is economic
			Lack of system planning and operational tools that combine economics and physics of DER
			How to move from dedicated network to broader access/public network

TABLE 5-3. CONCEPTUAL DESIGN OF PROPOSED IT ARCHITECTURE

CONCEPT NAME	BRIEF DESCRIPTION	KEY ELEMENTS	HIERARCHY	LINKAGES	C&C TECHNOLOGIES
Distributed, Intelligent Architecture	Intelligent devices throughout the electricity supply/demand chain creates lower risk, more secure, more scaleable intelligence	• Peer-to-peer • Overlapping, independent networks • Multiple time scales • Ability to support multiple business models and multiple applications • Ability to group assets and apply different control strategies	• Markets • Enterprises • Sites	• ISO/RTO • DR • DER • Utilities End-users • Aggregators/ESP	• Self-healing • Self-organizing • Adaptive • Heuristic/AI • Hierarchal/ supervisory • Classical control
Resources Allocation and Leveraged Power Handling System (RALPHS)	Command and control of distributed resources • Generation • Load management • Energy storage	• Two-way command/ control • Digital and analog data • Resource availability • Resource capacity (production or load curtailment capability) • DER PQ support (utility and customer based • Economic operating range	Economics ↔ Market supervision ↔ Operations Supervision ↔ Resources/sensors	• Sensory → supervisory • Supervisory → relay/CMD • SOH (Resource → supervisory) • Capacity available (generation → supervisory • Grid contribution (resource → supervisory)	• Models • Software • Sensors
Integrated Control Domain Architecture	• Multiple overlapping, interacting control domains, each having its own constituent community and inherent optimization priorities. • Overall collection of control domains operates in concert to optimize: market operation, security/availability, environmental management, and natural resource management. • Regulatory "control points" manage the previous optimization goals	Control domains: • Generation (central/ distributed) • RTO/ISO • Distribution utilization • Consumer (including DG, load response, storage, alternative fuels) • 3rd party services (EIS, facility management, device management) • Regulatory (DOE, EPA, NRC, etc.)	Regulatory → Macro control domains → Constituent control domains → Equipment	• Canada, Mexico • Suppliers (IT, OEMs, …) • Standards (IEEE, EIA, ISO, …) • Regulatory (federal, state, local)	• Control models (CM) • Distributed CM runtime • Secure authentication and trust architecture

TABLE 5-4. (MODIFIED FOCUS QUESTION) ACTION PLAN TO FILL THE KEY KNOWLEDGE GAPS

CONCEPT NAME AND DESCRIPTION	KEY ACTIONS	KEY MILESTONES	SCHEDULE	ROLES	NEXT STEPS
C&C Business Case A stake in the ground to define the DER marketplace	• Develop working definition for DER (conceptual model) • Define value chain and stakeholders • Evaluate consequences	• Present results of action taken to regulatory bodies and stakeholders • Implement new regulations • Reevaluate • Refine concept (continuing reevaluate/refine loop)	• 2003 (or earlier if possible) for Key Actions • 2004-5 for Key Milestones	• DOE: develop conceptual, regulatory, and economic models • Industry: develop technology and systems; implement them	• Put budget together now!! – start sooner rather than later
Standardization of Command and Control Use regulation to drive <u>key specific</u> areas for national C&C system	1. National energy C&C system mandated by government 2. System details and specific areas for standardization DEFINED by industry.	For Action #1: • Determine requirements • Work with congress to pass federal legislation • Pass legislation with timeline, methodology, and funding For Action #2: • Form joint industry/ government team to identify key regulatory control points	• Initiation following the establishment of the C&C Business Case plans • DER monitor, control, information flow project starts June 2002	• Government requires the development of standards • Industry defines the requirements • Regulatory agencies accept/adopt the developed standards	• Form a joint team of government and industry to develop standards • Industry to begin to lobby government to recognize need for standards
Creation and Validation of Value Propositions To determine and validate economically viable implementation strategies	• Develop concept model • Review with affected parties • Real-world validation • Economic analysis • "Fix" identified deficiencies (continuing loop between validation and "fix") • Scale	1. Approval of initial model by affected party 2. Funding resources secured 3. Real-world test bed validation completed 4. Apply scaling rules to different market segments.	Milestone 1: 3-6 months Milestone 2: 1-2 months Milestone 3: 24-36 months Milestone 4: 6-12 months	Milestone 1: • Government (funding) • Consultant (facilitate commercial/industrial/ residential model) • Segment representation (utility, commercial, industry, residential, vendor) Milestone 2: • Government • Segments representation Milestone 3: • Government (funding) • Segments representation Milestone 4: • Government (funding) • Univ./National Labs (market models and scaling) • Business (Realization of scaling	• Solicitation by government of interested parties • Funding set-aside

Chapter 6
Systems Architecture
Group B

C&C Services

Focus Question #1: What are the communication and control services that need to be provided to distributed energy devices to achieve cost-effective interoperability and integration with utility transmission and distribution systems?

There are many services that communications and control systems can provide to distributed energy devices that make them more cost-effective and improve their interoperability and integration with utility transmission and distribution systems. Table 6-1 identifies a number of these services.

In today's internet culture, electronic information exchange is a common occurrence. However, electronic device operators are hesitant to submit proprietary information across systems for fear that it can be intercepted by a third party. Additionally, information received from such operators is often questionable. Ensuring end-users that the information they transmit and receive on is accurate and secure is an ideal service goal for communication and control systems.

Group B Participants

Name	Organization
Rolf Carlson	Sandia National Laboratories
Marija Illic	Massachusetts Institute of Technology
Matt Johnson	Sentech
Kevin Komura	PJM Interconnection
Mark Olson	ICES – George Mason University
Rob Pratt	Pacific Northwest National Laboratory
John Schroeder	Airak
Jay Shah	Capstone Turbine
Paul Wang	Concurrent Technologies Corp
Randy West	Encorp
Larry Windley	DG InterConnect
Steve Windergren	Pacific Northwest National Laboratory/Battelle
Thomas Yeh	Connected Energy Corp.

Facilitator: Jennifer Miller, Energetics, Incorporated

Knowledge Gaps

Focus Question #2: What are the knowledge gaps that prevent existing communication and control technologies from providing services cost effectively today?

A variety of knowledge gaps prevent existing communication and control technologies from cost effectively providing services today (see Table 6-2). While they are grouped into six categories, it should be noted that these category headings are simply guidelines and that all of the gaps identified are interconnected across all categories.

The most significant gap is that there is no standard, universally accepted method for communicating information between connected devices and personnel. This information includes not only standard data formats exchanged system to system, but also the varying definitions of common terminology used repeatedly in the industry. This language breakdown causes a spiral effect throughout the distributed generation industry and prevents significant capacity increases. Another major theme that crosscuts many of the gaps is that electric utilities are not included as allies in the effort to increase distributed generation in the United States. A question raised repeatedly is "How do utilities make money from distributed generation?" Furthermore, serious concerns exist as to whether or not today's utilities will be able to meet the increasing demands they will face in the future.

With the stringent environmental laws in existence today, it is very difficult to both build new power plants and extend or create new transmission and distribution lines. Distributed generation can assist utilities in meeting the demands placed on them. However, it is vital that distributed generation devices be able to communicate with the utility they are connected to. Until utilities recognize distributed generation as a means of increasing their market share, they will always serve as a barrier to integration of distributed generation into the national grid.

Currently, there is no method of selling electricity in a retail market. Since the enactment of Public Utilities Regulatory Policy Act in 1978, non-utility generators of electricity markets have been guaranteed rights to sell the power they generate to the electricity grid. However, an owner of distributed generation cannot sell the excess power it generates to a local shop across town, as the technology does not exist to allow this type of microgrid retail market.

Conceptual Designs of Proposed IT Architecture

Focus Question #3: What is your proposed design of the information technology architecture in terms of key elements, linkages, hierarchies, and communication and control technologies?

Table 6-3 describes three independent designs for proposed information technology architecture. Each concept has both similarities and differences. It is recommended that these three designs be implemented as "pilot projects," thus lowering the barriers to entry and allowing their initiation to take place sooner.

The three concept designs each address different aspects of information technology architecture; however, they are all compatible, and if combined they could represent one grand scheme for a proposed information technology architecture. The designs take a "bottom up" approach in that they demonstrate that they have local markets which deal with local concerns. These local markets could then be linked, through independent arbitrators (see Figure 1), to form regional markets, which would address regional market issues. These designs demonstrate the need to look at two types of networks; the physical information (volts, vars, etc) and the market information (cost, prices, forecasted capacity upgrades, short- and long-term contracts, etc.). The systems address the need to leverage existing protocols to the maximum extent possible (i.e., to make it "internet-like"). They offer plans for audit trails of transactions as well as address the need to have a secure system that will ensure the information transmitted remains intact, genuine, and confidential.

Paths Forward

Focus Question #4: What is the path forward to developing robust designs for the architecture (action plan)?

As mentioned previously, these three concept designs can be effectively combined into one grand information technology architecture scheme. Each subgroup independently designed systems and identified the means of implementing these systems (see Table 6-4). These suggested paths all address different barriers to implementation (see Figure 2).

The design teams developed three concepts, the first suggested a viral approach be used, i.e., start to build the architecture at local markets with aggregated distributed generation and then combine these small local markets into a regional market. Next, a consortium should be established to address the standards and protocols used on the architecture. And finally, the proposed information technology architecture should focus on market structures and economic issues. If distributed generation does not become economically viable, then capacity increases will be stunted.

TABLE 6-1. C&C SERVICES

♦ = Number Of Votes Received For Top Priority Shown

IMPLEMENTATION POLICIES	INFORMATION SECURITY	MARKET/PRICE INFORMATION	AUTOMATION	QUALITY OF SERVICE
• Verification of compliance, standards, laws ♦ • Ability to manage services through enforcement of policies ♦ • Utility DG support guidelines ♦ • Procedure for when to be on or off grid (islanding)	• Guaranteed delivery of information (or failure notification) ♦♦♦♦♦ • Confidentiality or privacy ♦♦♦♦♦ • Provide SCADA II level cryptography for DER information services ♦♦ • Entity authentication, data authentication, non-repudiation of data, requests, actions, access control ♦♦	• Complete list of products and services - demand and supply functions for these ♦♦♦ • From a consumer: load (now, next) change load vs price vs emergency signal ♦♦♦ • Enable comparison of cost and value of source of electricity ♦ • Real time (define) cost of energy and purchase price of energy ♦ • From distribution substation: forecasted capacity expansion plan ($/MW) for DG, DER to bid against ♦ • From a supplier: price (now), (next) capacity available (now) (next)	• Plug and play for technical and pricing implementation ♦♦♦ • Secure remote control for management and control of the device ♦♦ • Monitoring of the monitor device	• Induce efficiency ♦ • Differentiated reliability and quality of service implantation, and price ♦

ADAPTABILITY	MARKET IMPLEMENTATION	OFF GRID INFORMATION (CUSTOMER SUPPORT)	DATA MANAGEMENT/ QUALITY	GRID INFORMATION
• Discovery services protocol, capability, ID, owner/operator, location ♦♦ • Means of dynamic aggregation of end users ♦ • Rolling upgrade for new service ♦ • Adaptation to price and system conditions ♦	• Service for negotiating bids ♦♦♦♦♦ • Implementation of contractual agreements • Provide settlements and multiple markets • Customer projects available for third party implementation or co-funding	• Bug feedback ♦ • Provide installation help like (800 number)	• Common information model ♦♦♦♦♦♦♦ • Recordation and archival of data produced and aggregated within a microgrid ♦ • DG data requirements based on DG size ♦	• Resource (or load) emissions profiles ♦♦ • Get from remote devices: real time values (MW, MVAR, etc) operation capability MWh “availability” – free choice ♦♦ • Status of other DE resources in local area ♦ • Visual interface indicating local grid conditions ♦ • Provide operating conditions ♦ • Provide control status

TABLE 6-2. KNOWLEDGE GAPS

♦ = Number Of Votes Received For Top Priority Shown

ECONOMIC	INFORMATION TECHNOLOGY	POLICY	SYSTEM INTEGRATION	GRID INFORMATION	ENVIRONMENTAL
• No retail electricity market ♦♦♦♦♦♦♦ – Need to address micro level – No structure to transmit electricity to specific target • How does a utility make money on DG ♦♦♦♦ • Don't know avoided costs of upgrades to distribution and sub-transmission ♦♦♦ • Don't have markets for T&D upgrades to support DG projects ♦ • Don't know how to value C&C and DG long-term impacts ♦ • What is this metric?	• Can we use current communication technologies or is a new infrastructure required? ♦♦♦♦ • How to implement privacy rules	• Privacy rules and other regulatory policies ♦♦♦♦ • Legal ramifications of owning and operating DG – liability, insurance, etc. ♦♦ • IEEE 1547 standards for DG interconnect ♦ • Security hierarchy for information	• Information exchange model ♦♦♦♦♦♦♦♦♦♦♦ – Data dictionary – Standardized, flexible data formats • Performance specifications ♦♦♦♦♦ – At all levels of industry • No well defined concepts for utilities of the future ♦♦♦ • How to design open access system for DER resources ♦♦ • DE market rule implementation adaptability ♦	• Don't know current load or where it's needed ♦♦♦♦ • Don't know how much or where or type of DG within customer premise ♦♦♦	• Don't know imports emission's per MW from various fossil fuel DG vs. central generation ♦♦♦♦

Table 6-3. Conceptual Design of Proposed IT Architecture

Concept Name	Brief Description	Key Elements	Hierarchy	Linkages	C&C Technologies
Smart Market Technology (SMART)	▪ Autonomous market based decision making enabled by mainstream communications, software, and hardware	▪ Market based control distributed decision making ▪ Stability control ▪ Resilient to failure component ▪ "real time, intelligent" metering	▪ Internet style scalable hierarchy	▪ Data: XML messages pub/sub ▪ Physical communications open (ex: wire, fiber, radio, satellite)	▪ Web interface ▪ Airak's sensors ▪ SCADA ▪ Embedded systems
Dynamic Energy Market Integration System (Dr. Ilic supplying schematic electronically)	▪ Multi-layered open access architecture which captures both special and temporal values ▪ Local markets for local benefits ▪ Regional markets for regional benefits	▪ Market supports RTO→ISO→Utility→DISCO→Customer ▪ Set of complete multi-markets (range: minutes to years) ▪ Long term markets for expansion needs for central generation and capacity	▪ Loads and forecasts passed upward, aggregated, posted, passed up in aggregated form to next higher level	▪ Standard data (IT) protocols (DNP, TCP/IP, ICCP, MMS) ▪ Flexible data model based on MW or impact ▪ 10–50W: 1 rotor, 1 frame ▪ 50-500W: 1 rotor, 2 frame ▪ 500-∞: 2 rotor, 2 frame	▪ Verifiable decision tools and information structure which allows distributed decision making at each different level and predictable system performance ▪ Need a data audit trail, recordation of transactions and archival meeting FERC standards for non-repudiation in real time/on-line ▪ Devices contracting at meter: equipment, appliances at customer premise negotiate with meter for service
Local Market Clearing Houses (see Figure 2)	▪ Multiple interconnected local markets	▪ Multiple small markets of loads and sources (includes DG) ▪ Each market requires a trusted clearing house ▪ Arbitrators interconnect clearing houses and facilitates transactions between markets ▪ Clearing houses are a source of: ▪ local market information ▪ communications and control	▪ Three level hierarchy ▪ DG/load ▪ Local market ▪ Local market interconnect	▪ Physical linkages ▪ Data communication ▪ Power distribution ▪ Business linkages ▪ Clearing house rules ▪ Arbitrator/clearing house interaction rules	▪ Internet based (distributed communication system) ▪ Smart loads

Figure 1. Local Market Clearing Houses Schematic

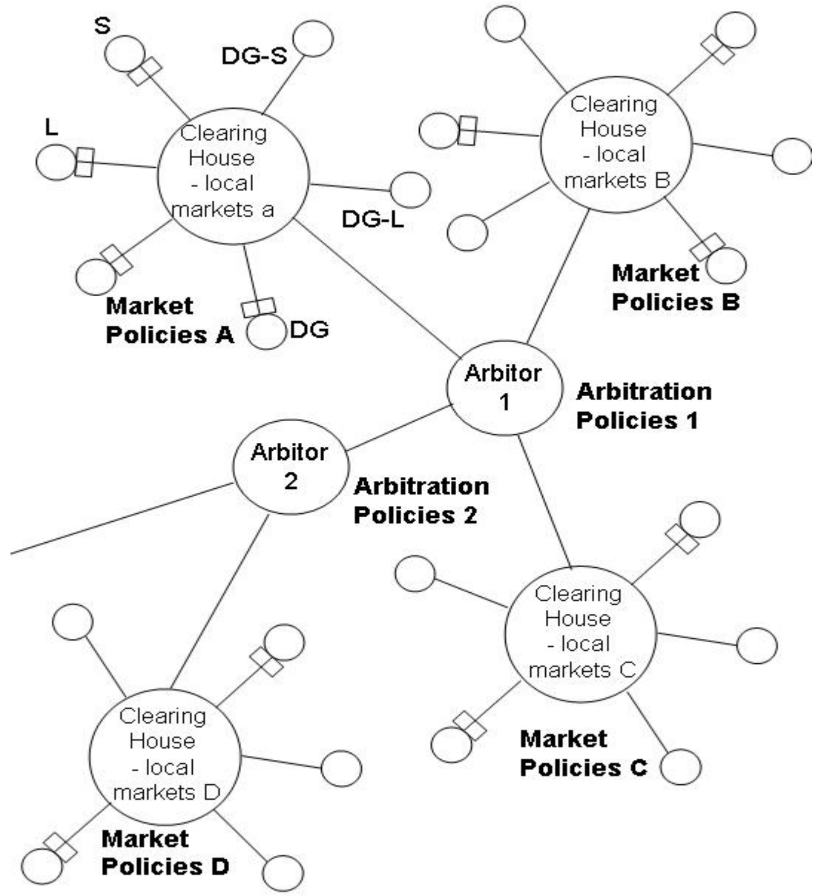


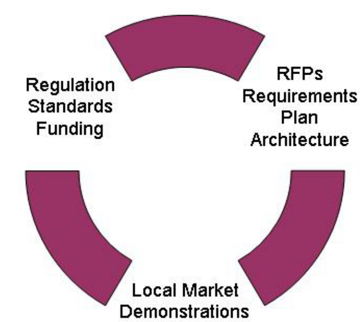
TABLE 6-4. PATHS FORWARD

CONCEPT NAME	KEY ACTIONS	KEY MILESTONES	SCHEDULE	ROLES	NEXT STEPS
Smart Market Technology (SMART)	▪ Create forum (group) of interested parties to develop RFPs and accept proposals ▪ Develop reference architecture document ▪ Create common information model ▪ From reference architecture identity interfaces for information exchange model ▪ As concepts mature more ideas into standards (SCC, ISO, IEC) ▪ Initiate R&D into simulations to test technology (communication and elec. System) market design ▪ Realize architecture framework in demonstration projects	1. Create forum with funding to coordinate meetings 2. Develop reference architecture, common information model, exchange model… 3. Initiate the R&D into simulation/test/demo	1. Forum ASAP 2. RFP reference architecture – 1st Quarter, 2003 3. Initiate simulation/test/demo – 3rd Quarter, 2003	▪ Convener (White hat org, DOE?) ▪ Participants ○ Vendors ○ Energy service providers ○ Educators ○ Labs ○ Consultants ▪ Standards and regulator organizations	▪ Formalize forum (start with workshop attendees) ▪ Identify convener and guiding body
Dynamic Energy Market Integration System *The economics of estimated spending change ½ trillions in 20 years should reflect 21st century technology and market support services for T&D*	▪ Changes in regulation open market access for T&D and other services ▪ There will have to be changes in regulatory environment for utilities to allow them sufficient ROI to participate as partners in this process ▪ Create communications systems and market structures and systems	1. Issues of connection standards (IEEE 1547, etc.) must be resolved 2. Create a simple, common language and communication standards and protocols – to make process transparent, open, and support all levels of DR 3. Create market operation and closing software, including auditing and verification 4. define privacy and information security procedures to serve interest of all parties	1. Complete ASAP 2. Start now (preliminary in 1 year, final in 2 years) 3. Start now (initial specifications- 2 years, final specifications 3 years) 4. Start now (preliminary 1 year, final 2 years)	1. Government catalyst, industry driven 2. New industry initiative, utilities/ISOs, vendors, DR & CC, end-users, Federal labs 3. New industry initiative, utilities/ISOs, vendors, DR & CC, end-users, Federal labs 4. New industry initiative, utilities/ISOs, vendors, DR & CC, end-users, Federal labs	▪ Organize/formalize industry initiative group ▪ Define and initiate demonstration/pilot projects ▪ Arrange funding for these activities

TABLE 6-4. PATHS FORWARD *(continued)*

CONCEPT NAME	KEY ACTIONS	KEY MILESTONES	SCHEDULE	ROLES	NEXT STEPS
Local Market Clearing Houses *Create an open system for a local market that allows market forces to transform a regulated system into a market based system* *For local market:* *- Minimize DG barriers* *- Enable smart loads* *- Create local trading market* *- Handle grid interaction*	▪ Set up a DG governmental agency with regulatory oversight power to drive pilot projects ▪ Goal of the pilot project is to explore a viable DG business case and technology viability ▪ Purpose of the pilot projects is to define and demonstrate local market policies, interconnections, and commerce policies ▪ Fund pilot projects	▪ Establish requirements for the pilot projects in the form of RFPs ▪ Pilot projects demonstrate DG can provide a viable energy economy on a local market basis ▪ Sufficient pilot projects on a "local" market basis to form interconnections of local markets		▪ Governmental DG oversight agency ▪ A body of co-operative entities (including utility) serving as "clearing house" ▪ DG consumers and sources ▪ Technology providers ○ DG resources ○ Metering ○ T&D connects ○ Clearing house and settlement services	

Figure 2. Trinity of Concept Designs of Proposed IT Architecture



Chapter 7
Closing Plenary

The U.S. Department of Energy can serve a useful function by bringing together technical working groups that represent distributed energy manufacturers, electric utilities, and information technology stakeholders. Unless the Department of Energy facilitates a process that involves these groups, progress may be slower than otherwise anticipated. Through such facilitated information exchange, the Department is in a unique position to educate state public utility commissions, energy and environmental regulators, and other key decision-makers in the private and public sectors.

Demonstration projects must validate profitable business models and the economic and social value of distributed energy. Such demonstration projects need to show that utilities, customers, manufacturers, and service providers can all benefit from a strong distributed energy environment. A means must be found to disseminate the results of these demonstration projects to all stakeholders including Federal, State, and local energy and environmental policy officials and interest groups.

National, standardized communications protocols for distributed energy systems must be developed. Existing communications technologies and systems can be used, including telephone lines, wireless systems, and the Internet. These systems need to be expanded to include interfaces between utility communications systems at both the distribution and transmission system levels. Still to be determined is the amount of bandwidth required to operate distributed energy systems, including the level of investment for build-out of the "last mile" of telecommunications infrastructure.

Because large-scale demonstrations will involve hundreds, if not thousands, of installations, incentives for participation from both utilities and customers will be needed. Participation in demonstrations will likely involve substantial resource and time commitments for customers, utilities, and providers of distributed energy equipment and information technology systems. In particular, there needs to be more outreach to utilities and regulatory commissions to obtain their support for demonstration programs. Innovative financial and cost sharing arrangements for effectively managing financial and technical risks will be needed.

APPENDIX A
List of Participants

Advanced Energy, Robert Wills

Airak, Incorporated, Paul Duncan

Alstom, Ali Ipakchi

American Electric Power, Harold Lampe, Bill Randle

Bonneville Power Administration, Mike Hoffman

California Energy Commission, Mark Rawson, Terry Surles

Capstone Turbine Corporation, Jay Shah

Caterpillar, Roger Jarman

Colorado State University, Wade Troxell

Concurrent Technologies Group, Paul Wang

Connected Energy Corporation, Larry Simpson, Thomas Yeh

DG Interconnect, Inc., Larry Windly

ENCORP, Randall West

Enercon Engineering, Inc., Rick Allison

Energetics, Inc., Jan Brinch, Brian Marchionini, Jen Miller, Rich Scheer, Ed Skolnik

Envenergy, Marc Fioravanti
EPRI, Frank Goodman

Honeywell ACS, Timothy Ruohoniemi

IBM-T.J. Watson Research Center, Ronald Ambrosio

ICES-George Mason University, Mark Olson

Infotility, David Cohen

Invensys Home Control Systems, Gregory Ehlers

Law Office, DC, Steven Rivkin

Lawrence Berkeley National Laboratory, Satish Kumar

Lively Utility, Mark Lively

Massachusetts Institute of Technology, Marija Ilic

National Fuel Cell Research Center, Jack Brouwer

National Renewable Energy Laboratory, Thomas Basso, Dick Deblasio

Oak Ridge National Laboratory, John Kueck

Pacific Northwest National Laboratory, Landis Kannberg, Steve Hauser, Robert Pratt, Mike Warwik, Steven Windergren

PJM Interconnection, Kevin Komora

Resource Dynamics Corporation, N. Richard Freedman, Paul Scheaffer

RHC, Ron Hofmann

Sandia National Laboratory, Abbas Akhil, Rolf Carlson

Southern California Edison, Stephanie Hamilton

Sentech, Inc., Matthew Johnson

Sixth Dimension, Inc., Sunil Cherian

Southern Company, Joe Schatz

Tridium, Inc., Phil Bomrad, John Petze

U.S. Department of Energy, Dale Dietzel, Eric Lightner, Joseph Galdo, William Parks

United Technologies Research Center, Robert Morgan

Utility Automation Integrators, Inc., SK Chauhan, Kirk Hanlin

Utility Consulting International, Frances Cleveland

APPENDIX B
Agenda

Communication and Control Systems for
Distributed Energy Implementation and Testing Workshop
May 14-15, 2002
Sheraton Reston Hotel
Reston, Virginia

"*Defining the Next Steps in Achieving Interoperability, Intelligent Control,
and Integration with Utility Systems*"

Day One – May 14, 2002

7:30 Registration and continental breakfast

8:30 Welcoming remarks

- Bill Parks, U.S. DOE - Program Manager Distributed Energy Resources and Electric Reliability
- Mark Rawson, California Energy Commission; Ron Hoffman, RHC
- Q&A

9:00 Discussion of distributed energy and communications and controls *terms and definitions*

- Industry perspective on information technologies - Ron Ambrosio, IBM
- Utility Perspective - Bill Randle, American Electric Power
- Potential Benefits of the Energy System Transformation – Landis Kannberg, Pacific Northwest National Laboratory
- Q&A

10:15 Discussion of breakout sessions, ground rules, and logistics

- Two tracks – (1) Demonstration and Testing (2) Architecture
- Four breakout groups – Demonstration and Testing “A” and “B”; Architecture “A” and “B”
- Four breakout sessions address four focus questions

10:30 Break

10:45 Breakout session and focus question #1

- Track (1) – *What are the issues, problems, barriers, and concerns associated with accomplishing large scale demonstrations of distributed energy and C&C technologies?*

- Track (2) – *What are the C&C services that need to be provided to distributed energy systems to achieve cost effective interoperability and integration with utility transmission and distribution systems?*

12:30 Lunch

- Terry Surles, California Energy Commission

1:30 Breakout session and focus question #2

- Track (1) – *What are the key outcomes (analysis questions) that the proposed demo(s) and test(s) need to address about C&C systems and DE devices?*

- Track (2) – *What are the knowledge gaps that prevent existing C&C systems from providing services cost-effectively today?*

3:15 Break

3:45 Breakout session and focus question #3

- Track (1) – *What would be your proposed design of a DER-C&C demo/test in terms of objectives, locations, # of points, technologies, and applications?*

- Track (2) – *What is your proposed design of the IT architecture in terms of key elements, linkages, hierarchies, and C&C technologies?*

5:30 Adjourn day one

6:00 Reception

Day Two – May 15

7:30 Continental breakfast

8:00 Re-convene breakouts and re-cap day one

8:15 Breakout session #4

- Track (1) – *What is the path forward to implementation (action plan)?*

- Track (2) – *What is the path forward to developing robust designs for the architecture (action plan)?*

9:45 Breakout groups select spokesperson and prepare oral report

10:00 Break

10:30 Closing plenary session

- Breakout group reports
- Discussion of gaps and crosscutting themes
- Final thoughts and next steps

12:00 Adjourn workshop

Appendix C
Acronyms

CM .... Control Model
DA .... Distribution Automation
DNP .... Distributed Network Protocol
EIA .... Energy Information Administration
EIS .... Energy Information Services
ESP .... Energy Service Provider
ID .... Identify/identification
IED .... Intelligent Electronic Device
IEEE .... Institute of Electrical and Electronic Engineers
IP .... Internet Protocol
ISO (1) .... International Standards Organization
ISO (2) .... Independent System Operator
IT .... Information Technology
MMS .... Materials Manufacturing Specifications
MW .... Megawatt
MWh .... Megawatt hour
MVAR .... Mega Volt-Amp Reactive
OEM .... Original Equipment Manufacturers
PQ .... Power Quality
R&D .... Research and Development
RFP .... Request for Proposal
ROI .... Return on Investment
RTO .... Regional Transmission Operator
SCADA .... Supervisory Control and Data Acquisition
SCC .... Standards Coordinating Committee
SMART .... Smart Market Technology
T&D .... Transmission and Distribution
TCP .... Transfer Control Protocol

APPENDIX D
Contact List

More information about the workshop and related activities can be found at www.eren.doe.gov/der or by contacting the following individuals:

Name	Organization	E-mail
Steve Hauser	Pacific Northwest National Laboratory	Steven.Hauser@pnl.gov
Eric Lightner	U.S. Department of Energy	eric.lightner@ee.doe.gov
Brian Marchionini	Energetics, Inc.	bmarch@energeticsinc.com
Rich Scheer	Energetics, Inc.	rscheer@energeticsinc.com